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Antimicrobial Susceptibility of *Aeromonas* Species Isolated from Patients with Diarrhea

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In vitro susceptibility to 17 antimicrobial agents was determined for *Aeromonas caviae*, *A. hydrophila*, and *A. sobria* isolated from feces of patients with diarrhea. The three *Aeromonas* species shared a similar susceptibility pattern, except to cephalothin. Of the oral antimicrobial agents, the quinolones, followed by chloramphenicol, were most active; trimethoprim-sulfamethoxazole and tetracycline had good but variable activity.

The motile aeromonads are being increasingly implicated as important causes of gastroenteritis, particularly in children. The epidemiologic data supporting an enteropathogenic role for *Aeromonas* spp. are contradictory (1, 2, 5, 6, 13); nonetheless, some investigators have isolated these microorganisms more frequently from patients with diarrhea than from asymptomatic controls (1, 2, 6). Earlier studies (1, 3, 4) have identified *Aeromonas* isolates as *Aeromonas hydrophila* collectively. More recent data make a distinction between the three currently recognized *Aeromonas* species, namely *A. caviae*, *A. hydrophila* and *A. sobria* (9, 11, 13). Most studies on the antimicrobial susceptibility of *Aeromonas* clinical isolates involved isolates recovered from various sites, e.g., blood, wound, respiratory tract, and gastrointestinal tract. Fainstein et al. (3) tested strains that were obtained from blood cultures, but the other investigators either did not specify the source of the specimen or combined isolates from different body sites (4, 9, 12). Two recent studies (11, 13), however, reported on the in vitro antimicrobial susceptibility of *Aeromonas* fecal isolates. We add our experience to these reports.

We studied the antimicrobial susceptibility of various *Aeromonas* species isolated from feces of children and adults with diarrhea. Our data should provide additional information on whether the motile aeromonads isolated from patients with gastroenteritis share a common susceptibility pattern as a group or whether interspecies differences exist. Some emphasis has been placed on antimicrobial agents that could be administered orally because of possible therapeutic implications for patients with *Aeromonas*-associated diarrhea.

The fecal specimens were inoculated onto sheep blood agar with and without 30 μg of ampicillin per ml. *Aeromonas* spp. were identified by a battery of tests on oxidase-positive isolates. The set of tests included reactions in triple sugar iron agar, motility indole ornithine medium, nutrient broth with and without 1% NaCl, and the API 20E system (Analytab Products, Plainview, N.Y.). Identification of the *Aeromonas* isolates to the species level was based on selected tests derived from criteria suggested by Popoff (10) and Janda et al. (8). The tests were esculin hydrolysis, arabinose utilization, salicin fermentation, gas production from glucose, Voges-Proskauer, lysine decarboxylase activity, and hemolysin production; the assay mixtures were incubated at 37°C. The susceptibility to 17 antimicrobial agents was determined by the National Committee for Clinical Laboratory Standards microbroth method with cation-supplemented Mueller-Hinton broth and an inoculum of approximately 5×10^5 CFU/ml.

Thirty-nine *Aeromonas* strains were isolated from 29 children and 8 adults from March 1985 through March 1986. All the patients had diarrhea and all lived in the Oklahoma City area. The specimens were also cultured for *Campylobacter*, *Salmonella*, *Shigella*, and *Yersinia* spp. *Aeromonas* spp. were the sole isolates from 31 patients; *Salmonella* and *Shigella* spp. were also isolated from 4 and 2 patients, respectively. *A. hydrophila* and two other *Aeromonas* strains that could not be identified further by the criteria we used for speciation were isolated from one patient. This patient was the only immunocompromised host in this study. The clinical significance of the isolation of *Aeromonas* spp. from our patients is not clear, especially since we do not know the prevalence of asymptomatic carriage in our population. We are currently doing studies that address these questions.

There were 21 *A. caviae*, 10 *A. hydrophila*, and 5 *A. sobria* strains; 3 isolates could not be identified to species level. The results of the susceptibility tests are shown in Table 1. The three species share a similar pattern of susceptibility to 16 of the antimicrobial agents. *A. sobria* appears to be more susceptible to the cephalosporins, as well as to chloramphenicol, tetracycline, and trimethoprim-sulfamethoxazole; however, only five strains were tested. With the exception of cephalothin, all the cephalosporins used in the study demonstrated very good activity against the motile aeromonads. Of the aminoglycosides, gentamicin was the most active. Exquisite sensitivity to the quinolones was exhibited by all the isolates; a similar observation was noted by Reinhardt and George (11). In addition to the quinolones, the other antimicrobial agents that could be administered orally and that had good activity against *Aeromonas* spp. were chloramphenicol, tetracycline, and trimethoprim-sulfamethoxazole. All three *Aeromonas* species were resistant to the amoxicillin-clavulanic acid combination, although the MIC of amoxicillin for 90% of the strains was at least eightfold lower than that of ampicillin.

Janda and Motyl (7) reported recently that 14 of 20 *A. sobria* strains they tested were susceptible to cephalothin and suggested cephalothin susceptibility as a potential marker for the *A. sobria* groups. Our results showed that 4 of

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TABLE 1. MICs of selected antimicrobial agents against *Aeromonas* strains isolated from patients with diarrhea

Antimicrobial agent	*A. caviae* (*n* = 21)			*A. hydrophila* (*n* = 10)			*A. sobria* (*n* = 5)
	Range	MIC_{50}[a]	MIC_{90}[a]	Range	MIC_{50}	MIC_{90}	MIC for individual isolates[b]
Amikacin	2–32	4	16	2–8	4	8	1, 8 (3), 16
Gentamicin	≤0.03–4	0.06	0.5	≤0.03–1	0.12	0.5	0.25, 0.5, 1 (2), 2
Tobramycin	≤0.03–4	0.12	1.0	0.25–2	0.5	2	0.25, 0.5 (2), 2, 4
Cephalothin	32–>128	128	128	2–>128	128	>128	2 (4), 32
Cefuroxime	1–8	2	8	≤0.12–4	1	4	≤0.12, 0.25 (2), 0.5, 2
Cefoperazone	0.5–4	1	4	≤0.12–4	0.5	2	≤0.12, (2), 0.25 (2), 4
Cefotaxime	≤0.12–2	≤0.12	0.5	≤0.12–1	≤0.12	0.5	≤0.12, (4), 0.5
Ceftriaxone	≤0.12–2	0.25	1.0	≤0.12–1	≤0.12	1	≤0.12 (4), 16
Moxalactam	≤0.06–0.25	≤0.06	0.12	≤0.06	≤0.06	≤0.06	≤0.06 (5)
Ampicillin	64–>256	>256	>256	128–>256	256	>256	256, >256 (4)
Amox/clav[c]	4/2–32/16	16/8	16/8	4/2–32/16	16/8	32/16	16/8 (3), 32/16 (2)
Chloramphenicol	1–8	2	4	0.25–2	1	2	≤0.06, 0.5 (3), 1
Tetracycline	0.25–64	2	4	0.12–64	1	16	0.25, 0.5, 1 (2), 32
TMP/SMZ[d]	0.12/2.5–4/80	0.5/10	2/40	0.12/2.5–8/160	1/20	8/160	0.12/2.5 (2), 0.5/10, 1/20, 4/80
Ciprofloxacin	≤0.008	≤0.008	≤0.008	≤0.008	≤0.008	≤0.008	≤0.008 (4), 0.015
Enoxacin	≤0.008–0.12	≤0.008	0.03	≤0.008–0.03	≤0.008	0.03	≤0.008 (3), 0.015 (2)
Ofloxacin	≤0.008–0.06	≤0.008	0.03	≤0.008	0.008	0.008	≤0.008 (4), 0.015

[a] MIC_{50}, MIC for 50% of the strains; MIC_{90}, MIC for 90% of the strains.
[b] The number in parentheses refers to the number of isolates with the MIC indicated.
[c] Amoxicillin-clavulanic acid.
[d] Trimethoprim-sulfamethoxazole.

the 5 *A. sobria* strains, all 3 strains that could not be identified to species level, 2 of the 10 *A. hydrophila* strains, and none of the *A. caviae* strains were susceptible to cephalothin. Susceptibility to cephalothin appears to be a useful additional criterion in the identification of *A. sobria*, but the small number of isolates that have been tested to date make such a conclusion tentative.

The role of antimicrobial therapy in the management of *Aeromonas*-associated diarrhea has not yet been defined. On the basis of available data, including our unpublished observations, *Aeromonas*-associated gastroenteritis generally has a mild and self-limited course. Approximately one-third of the patients, however, may have protracted diarrhea, lasting for more than 2 weeks (6). This group of patients could conceivably benefit from antimicrobial therapy, particularly with the orally administered drugs.

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